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The water needed to have Italians eat pasta and pizza

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Contents

Summary

Problems of freshwater scarcity and pollution are related to water use by farmers, industries and households. The term 'water users' has always been interpreted as 'those who apply water for some purpose'. As a result, governments responsible for water resources management have traditionally targeted their policies towards those water users. Recently, however, it has been shown that this approach is limited. Final consumers, retailers, traders and all sorts of businesses active along the supply chains of final consumer goods remain out of the scope of water policies. This is strange, given the fact that all water use in the world is ultimately linked to final consumption by consumers. It is therefore interesting to know the specific water requirements of various consumer goods, particularly for goods that are water-intensive, like food items, beverages, bio-energy and materials from natural fibres. This is relevant information for consumers, but also for retailers, traders and other businesses that play a central role in supplying those goods to the consumers.

The aim of this report is to estimate the water use related to two products that are typical to Italian consumers: pasta and pizza margherita. We use the water footprint concept as a tool to quantify and localise this water use. The water footprint of a product is the volume of freshwater used to produce the product, measured at the place where the product was actually produced. It refers to the sum of the water use in the various steps of the production chain.

Earlier studies showed that, when expressed per capita, Italy has one of the largest water footprints of the world, together with other South European countries and the US. The water footprint of the average Italian is 2330 m^3/yr, while the global average amounts to 1240 m^3/yr. This study shows that the water footprint of dry pasta made in Italy amounts to 1924 litres of water per kilogram of pasta. The water footprint of one pizza margherita – assuming a total pizza weight of 725 gram – is 1216 litres of water.

The impact of the water footprints of pasta and pizza depends on the vulnerability of the water systems where the water footprints are located. The impact of the water footprint of pasta is most severe in Puglia and Sicily, where groundwater overexploitation for durum wheat irrigation is common. The impact of the water footprint of pizza is more diverse. It is concentrated in the first step of the supply-chain of tomato puree and mozzarella, i.e. in the cultivation of tomatoes and the feed crops of dairy cows. The bread wheat used for the pizza base does not have large impacts. The water footprint impact of the tomato puree on the pizza is concentrated in Puglia (groundwater overexploitation and pollution related to tomato cultivation) and Emilia-Romagna (water pollution). The water footprint impact of mozzarella lies mostly in the effects of water use for producing the feed ingredients for the dairy cows. Mozzarella production further poses a potential threat to water quality, mostly in the Po valley, but this problem seems to be properly regulated, although possibly not fully controlled.

1. Introduction

Problems of freshwater scarcity and pollution relate to water use by farmers, industries and households. The term ‘water users’ has always been interpreted as ‘those who apply water for some purpose’. As a result, governments responsible for water resources management have traditionally targeted their policies towards those water users. Recently, however, it has been shown that this approach is limited (Hoekstra and Chapagain, 2007, 2008). Final consumers, retailers, traders and all sorts of businesses active along the supply chains of final consumer goods remain out of the scope of governmental policies aimed to mitigate water scarcity and pollution. This is strange, given the fact that all water use in the world is ultimately linked to final consumption by consumers. It is therefore interesting to know the specific water requirements of various consumer goods, particularly for goods that are water-intensive, like food items, beverages, bio-energy and materials from natural fibres. This is relevant information for consumers, but also for retailers, traders and other businesses that play a central role in supplying those goods to the consumers.

The concept of the ‘water footprint’ has been proposed as an indicator of water use that looks at both direct and indirect water use of a consumer or producer (Hoekstra, 2003). The water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business (Hoekstra and Chapagain, 2008). Water use is measured in terms of water volumes consumed (evaporated) and/or polluted per unit of time. A water footprint can be calculated for any well-defined group of consumers (e.g. an individual, family, village, city, province, state or nation) or producers (e.g. a public organization, private enterprise or economic sector). The water footprint is a geographically explicit indicator, not only showing volumes of water use and pollution, but also the locations. The water footprint of a product is the volume of freshwater used to produce the product, measured at the place where the product was actually produced. It refers to the sum of the water use in the various steps of the production chain.

The water footprints of various products have been studied in more or less detail, including cotton, coffee, tea, tomatoes, bio-ethanol and biodiesel (Chapagain et al., 2006; Chapagain and Hoekstra, 2007; Chapagain and Orr, 2009; Gerbens-Leenes et al., 2009). The current report addresses two specific consumer products not studied before: pasta and pizza. The study focuses on Italy, origin of both products and still a huge producer and consumer.

When expressed per capita, the Italian consumers have one of the largest water footprints of the world, together with other South European countries and the US. The water footprint of the average Italian consumer is 2330 m^3/yr, while the global average amounts to 1240 m^3/yr (Hoekstra and Chapagain, 2008). Within Italy, agriculture is the main water consuming sector, adding up to more than 70% of the total water demand, with its consequent pressure on Italian surface and groundwater resources (ibid.). Furthermore, Italy is one of the main wheat consuming countries in the world (FAO, 2008), probably due to the fact that pasta and pizza are the most popular dishes in Italy, with each Italian eating on average 28 kg of pasta every year (BBC, 2007). Pasta versus pizza is Italy’s great debate.

This study analyses the water footprint of Italian pasta and pizza margherita. Disclosing this type of information could increase awareness among consumers, which is a precursor to improve water governance.

The study considers the so-called 'green water footprint' (consumptive use of rainwater), 'blue water footprint' (consumptive use of ground- or surface water) and 'grey water footprint' (volume of polluted water that associates with the production of goods and services). In water-scarce areas, knowing the water footprint of a good or service can be useful for determining how best to use the scarce water available. In this sense, it is important to establish whether the water used proceeds from rainwater evaporated during the production process ('green water') or surface or groundwater evaporated as a result of the production of the product ('blue water'). Traditionally, emphasis has been given to blue water through the "miracle" of irrigation systems. However, an increasing number of authors highlight the importance of green water (Rockström, 2001; Falkenmark, 2003; Falkenmark and Rockström, 2004; CAWMA, 2007).

First of all, we have analysed – per region – the water footprints of the three primary crops involved: durum wheat (*Triticum durum* Desf.), bread wheat (*Triticum aestivum* L.) and tomato (*Solanum lycopersicum* L.). Subsequently, we estimated at a national scale the water footprints of the direct pasta and pizza ingredients (i.e. durum wheat flour, bread wheat flour, tomato puree and mozzarella). Then, the water footprints of the different ingredients were added to arrive at overall estimates for the water footprints of pasta and pizza margherita. Finally, an impact assessment of the water footprint of pasta and pizza margherita production in Italy was carried out, identifying the hotspots or high risk areas.

2. Method and data

2.1 Water footprint of primary crops

The water footprints of primary crops are calculated using the methodology developed by Hoekstra and Hung (2002; 2005) and Chapagain and Hoekstra (2003; 2004). With respect to the distinction between the green, blue and grey water footprint, the research follows Hoekstra and Chapagain (2008).

The total crop water requirement, effective rainfall and irrigation requirements per region have been estimated using the CROPWAT model (Allen et al., 1998; FAO, 2003a). The calculation has been done using climate data for the major crop-producing regions (Appendix I) and a specific cropping pattern for each crop according to the type of climate. The climate data have been taken from the CLIMWAT database (FAO, 2003b) for the most appropriate climatic stations located in the major crop producing regions (ISTAT, 2008) (Appendix I). For regions with more than one climate station, the data for the relevant stations have been equally weighed assuming that the stations represent equally sized crop producing areas. The actual irrigation water use is taken equal to the irrigation requirements as estimated with the CROPWAT model for every region.

The 'green' water footprint of the crop (m^3/ton) has been estimated as the ratio of the green water use (m^3/ha) to the crop yield (ton/ha), where total green water use is obtained by summing up green water evapotranspiration over the growing period. Green water evapotranspiration is calculated with a time step of five days, as the minimum of effective rainfall and crop water requirement. The 'blue' water footprint of the crop has been taken equal to the ratio of the volume of irrigation water used to the crop yield. Since data on irrigated and rain-fed production per crop were not available, crop water requirements are assumed to be always fully satisfied. Both green and blue water footprints have been estimated separately by region. Then, national average green and blue water footprints have been calculated on the basis of the respective share of each region to the national production. The major crop producing regions combined accounted for more than 99 per cent of the total national production (Appendix I). Data on average crop yield and production by region are taken from the Italian National Institute of Statistics (ISTAT, 2008). Crop coefficients for different crops are taken from FAO (Allen et al., 1998; FAO, 2003a). Table 2.1 shows the growing periods assumed.

Table 2.1 Planting and harvesting dates and yield for wheat and tomatoes in Italy.

Commodity	Planting date *	Harvesting date *	Yield (ton/ha) **
Durum wheat	1 Dec.	30 May	2.7
Bread wheat	1 Dec.	30 May	4.9
Fresh tomato	15 May	17 October	35
Industrial tomato	15 May	17 October	59

** Sources: Allen et al., 1998; Chapagain and Hoekstra (2004)*
*** Source: ISTAT (2008)*

The 'grey' water footprint of a primary crop (m^3/ton) is calculated as the load of pollutants that enters the water system (kg/year) divided by the maximum acceptable concentration for the pollutant considered (kg/m^3) and the crop production (ton/year) (Hoekstra and Chapagain, 2008). In this study, nitrogen was chosen as an indicator of the impact of fertiliser use in the production systems. The total volume of water required per ton of N is calculated considering the volume of nitrogen leached (ton/ton) and the maximum allowable concentration in the free flowing surface water bodies. The quantity of nitrogen that reaches free flowing water bodies has been assumed to be 10 percent of the applied fertilization rate (in kg/ha/yr) (following Hoekstra and Chapagain, 2008). The standard recommended by the European Nitrates, Groundwater and Drinking Water Directives for nitrate in water is 50 milligrams per litre (measured as NO_3^-). This is very similar to the drinking water standard recommendation by the US Environmental Protection Agency (EPA, 2005), which is 10 mg N per litre, equivalent to about 45 mg NO_3^- per litre. The standard of 10 mg N per litre was used to estimate the volume of water necessary to dilute polluted leaching flows to permissible limits. This is a conservative approach, since the natural background concentration of N in the water used for dilution has been assumed negligible. Data on the application of nitrogen fertilisers have been obtained from the FERTISTAT database (FAO, 2007).

The effect of the use of other nutrients, pesticides and herbicides on the environment has not been analysed, mainly because of three reasons. First, for many chemicals data on application rates per crop are not available. Second, good estimates on the fractions that reach the water bodies by leaching or runoff are very difficult to obtain. The problem for a substance like phosphorus is for instance that it partly accumulates in the soil, so that not all P that is not taken up by the plant immediately reaches the groundwater, but on the other hand may do so later. Finally, there do not exist broadly agreed water quality standards for all substances.

2.2. Water footprint of crop and livestock products

The water footprint of crop and livestock products (like wheat flour, pasta, tomato puree and mozzarella) is calculated by dividing the water footprint of the root (input) product by the product fraction (Hoekstra and Chapagain, 2008). The latter is defined as the quantity of the processed product obtained per quantity of root product. If the root product is processed into two or more different products, the water footprint of the root product is distributed across its separate products, which is done proportionally to the value of the resultant products. The value fraction for a processed product is defined as the ratio of the market value of the product to the aggregated market value of all the products obtained from the root product. If processing involves some water use, the process water use is added to the water footprint of the root product before the total is distributed over the various processed products. The product fractions for various crop and livestock products are derived from different commodity trees as defined in FAO (2003c) and Chapagain and Hoekstra (2004).

In order to calculate the water footprint of livestock products (e.g. mozzarella from cow milk) the water footprint of the animal has to be estimated. The water footprint of live animals can be calculated based on the water footprint of their feed and the volumes of drinking and service water consumed during their lifetime (Hoekstra and Chapagain, 2008). Obviously, one will have to know the age of the animal when slaughtered and the diet of the animal during its various stages of life. The type and quantity of feed of cows during the various stages of life were taken from Chapagain and Hoekstra (2004). The milk yield and live weight of an adult cow in Italy were obtained from FAO (2003c).

3. The water footprint of pasta

3.1 The water footprint of durum wheat

The basis for pasta is durum wheat, an annual grass very similar to bread wheat but differing in the larger, harder grains, higher protein content and different chromosome number (Van Wyk, 2005). It is cultivated in relatively dry regions and harvested in the same way as wheat and other cereals (ibid.). Italian durum wheat is cultivated mainly in southern Italy (ISTAT, 2008). The national average green water footprint of durum wheat is 748 m^3/ton; the blue water footprint is 525 m^3/ton. Regional differences in both total water consumption and the green-blue ratios, however, are substantial (see Fig. 3.1 and Appendix I). Puglia and Sicily are particularly strong in the production of durum wheat; the blue water proportions in these regions are relatively large (nearly 50%).

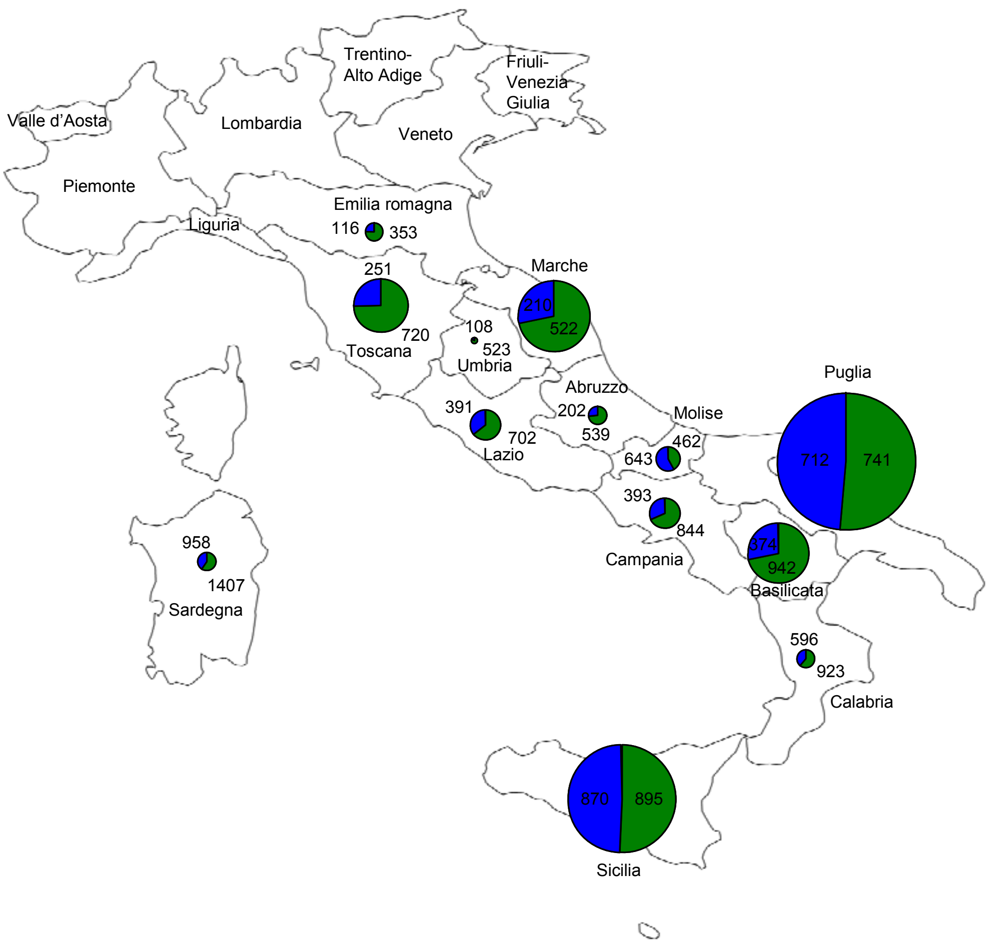

Fig. 3.1 Green and blue water footprint for durum wheat production by region. The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

The grey water footprint of durum wheat was estimated at country level. Only water pollution through the leaching of nitrogen fertiliser was considered. Nitrate is essential for plant growth but excessive amounts in water represent a major pollution problem. The grey water footprint shows the volume of water required to dilute the fertilisers that reached the water system. Based on the average N fertiliser application rate, an assumed leaching percentage of 10% and a nitrogen water quality standard of 10 mg/l, the grey water footprint of durum wheat is estimated to be 301 m^3/ton (Table 3.1).

Summing up the green, blue and grey water footprint of durum wheat, we arrive at an estimated total water footprint of 1574 m^3/ton (Table 3.2). For pasta, the durum wheat grains need to be processed into flour. About 72% of the original durum wheat weight becomes flour (semolina); the rest consists of the wheat bran and germ (Fig. 3.2). The semolina constitutes 88% of the total value of the two separate products. Given a total water footprint of durum wheat of 1574 m^3/ton, we can calculate that the water footprint of semolina is (1574×0.88/0.72=) 1924 m^3/ton.

Table 3.1 Nitrogen application and the associated grey water footprint for the production of durum wheat in Italy.

	Average N fertiliser application rate	Area*	Total N fertiliser applied**	Nitrogen leached to the water bodies	EPA (2005) standard	Volume of dilution water required	Production*	Grey water footprint
	kg/ha	ha	ton/year	ton/year	mg/l	10^6 m^3/year	ton/yr	m^3/ton
Durum wheat	82	1612706	132242	13224	10	1322	4387863	301

* ISTAT for the year 1999-2007 (ISTAT, 2008)

** FAO (2007) for the year 1999/2000

Table 3.2 The water footprint of durum wheat and durum wheat flour made in Italy.

	Water footprint (m^3/ton)			
	Green	Blue	Grey	Total
Durum wheat	748	525	301	1574
Durum wheat flour (semolina)	914	642	368	1924

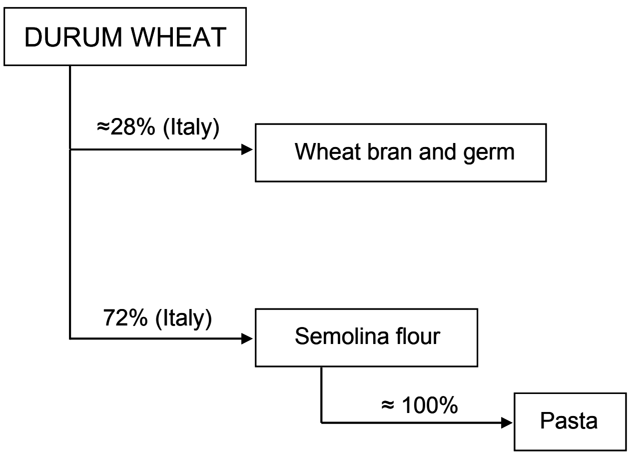

Fig. 3.2 Pasta production diagram including product fractions. Source: based on FAO (2003c).

3.2 The water footprint of pasta

Durum wheat has a very hard grain with a low gluten content, which makes it unsuitable for bread but ideal for pasta, gnocchi, couscous and bulgur. The wheat is milled in such a way that the grain is separated into bran, germ and semolina (Fig. 3.2). Authentic pasta is simply durum semolina to which various liquids (water, milk or eggs) are added. Pasta can be found in dried (pasta secca) and fresh (pasta fresca) varieties depending on what the recipes call for. Pasta is dried in a process at specific temperature and time. Traditional pasta is allowed to dry slower, up to 50 hours at a much lower temperature than mass-produced pasta, which is dried at very high temperatures for a short time. The shape varies from small (soup pastas) to long and thin (spaghetti and numerous others, used for boiling), flat (e.g. lasagna, tortiglioni, used for baking) or filled (e.g. cannelloni, ravioli, tortellini, tortelloni). The correct degree of cooking is known as *al dente*. Concerning its nutritional value, durum wheat has a slightly lower food value than bread wheat (Van Wyk, 2005).

For the purpose of this study we have assumed that pasta is made from semolina (1 kg), water (0.5 l) and salt. The water is removed later again when drying the pasta. The water footprint of dry pasta is equal to that of the semolina it is made from, i.e. 1924 litres/kg. The green component in this total figure is 48%, the blue component 33% and the grey component 19%. Taking into account that each Italian eats on average 28 kg of pasta every year (BBC, 2007), the water footprint of pasta consumption by an Italian inhabitant is 54,000 litres/year. In relative terms, this is about 2% of the average Italian water footprint (2330 m^3/cap/yr).

Given an Italian population of almost 60 million people, the water footprint of Italian pasta consumption amounts to about 3200 million m^3 per year. This quantity is equivalent to the volume of water required to fill more than one million swimming pools (one swimming pool contains 2500 m^3 of water).

4. The water footprint of pizza margherita

4.1 The water footprint of bread wheat

The base of a pizza is made from bread wheat flour. Bread wheat (soft wheat) has a very high nutritive value and contains 60-80% carbohydrates (mainly starch), 8-15% protein (all the essential amino acids except lysine, tryptophane and methionine) and various vitamins (especially B and E). The energy yield is 330 kcal per 100 g. (Van Wyk, 2005). According to our calculations, the green water footprint of Italian bread wheat is 495 m^3/ton on average, while the blue water footprint is 125 m^3/ton. Regional-specific data are provided in Appendix II. Compared with the water footprint of durum wheat, bread wheat consumes half of the amount of water per ton. This difference is mainly due to the different yields and production conditions of bread and durum wheat. Bread wheat is an annual crop adapted to a wet winter and rain-free summer (Van Wyk, 2005) and is mainly produced in the northern part of Italy (Fig 4.1), whereas durum wheat is essentially produced in the southern regions (Fig. 3.1). In the north of Italy, yields are higher due to different weather and soil conditions (Bianchi, 1995).

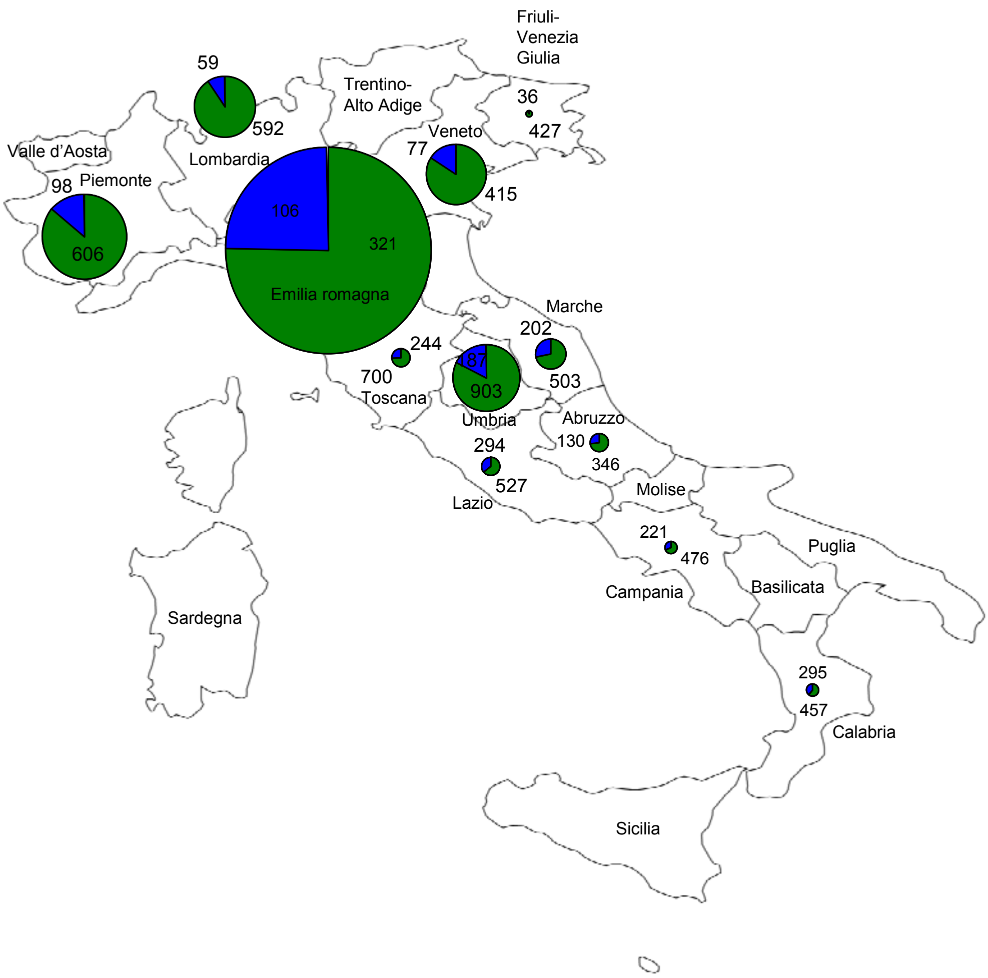

Fig. 4.1 Green and blue water footprint for bread wheat production by region. The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

The grey water footprint of bread wheat was estimated at country level in the same way as the water footprint of durum wheat (see Section 3.1). The results are shown in Table 4.1. When looking at bread versus durum wheat, the grey water footprint related to nitrogen pollution is notably lower for bread wheat, amounting to 166 instead of 301 litre/kg.

Adding the green, blue and grey component of the water footprint gives a total water footprint of bread wheat of 786 m^3/ton (Table 4.2). When the grains are ground into flour, 72% of the original wheat weight becomes flour, the remaining 18% are the wheat pellets (Fig. 4.2). The wheat flour constitutes 88% of the total value of the two different products. Given a total water footprint of bread wheat of 786 m^3/ton, we can calculate that the water footprint of bread wheat flour is (786×0.88/0.72=) 961 m^3/ton. The total water footprint is composed as follows: 63% green, 16% blue and 21% grey.

Table 4.1 Nitrogen application and the associated grey water footprint for the production of bread wheat in Italy.

	Average N fertiliser application rate	Area*	Total N fertiliser applied**	Nitrogen leached to the water bodies	EPA (2005) standard	Volume of dilution water required	Production*	Grey water footprint
	kg/ha	ha	ton/year	ton/year	mg/l	10^6 m^3/year	ton/yr	m^3/ton
Bread wheat	82	629778	51642	5164	10	516	3111352	166

* ISTAT for the year 1999-2007 (ISTAT, 2008)

** FAO (2007) for the year 1999/2000

Table 4.2 The water footprint of bread wheat and bread wheat flour made in Italy.

	Water footprint (m^3/ton)			
	Green	Blue	Grey	Total
Bread wheat	495	125	166	786
Bread wheat flour	605	154	202	961

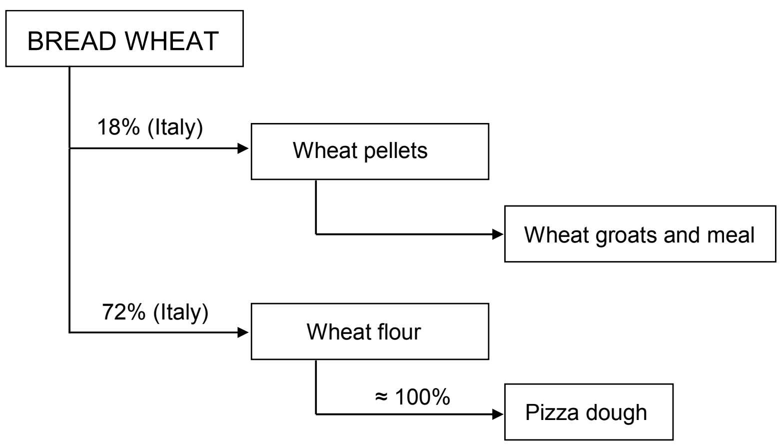

Fig. 4.2 Pizza dough production diagram including product fractions. Source: based on FAO (2003c).

4.2 The water footprint of tomato

In this study, we assume that pizza is cooked with puree from industrial tomatoes. Italy is one of the main producers of industrial and processed tomato worldwide (FAS, 2001). However, since fresh tomatoes are sometimes used instead of or in addition to tomato puree from industrial tomatoes, we have estimated the water footprint of both fresh and industrial tomatoes (Appendix II).

Fresh tomatoes are primarily produced in southern regions (Sicily and Calabria), using mainly blue water resources (Fig. 4.3). The national average green water footprint of fresh tomatoes is 44 m^3/ton; the average blue water footprint is 124 m^3/ton. The water footprint of industrial tomato is smaller than that of fresh tomato: the green water footprint is 35 m^3/ton and the blue water footprint is 60 m^3/ton. As shown in Fig. 4.4, industrial tomatoes are produced in other regions than the fresh tomatoes, mainly in Emilia Romagna and Puglia.

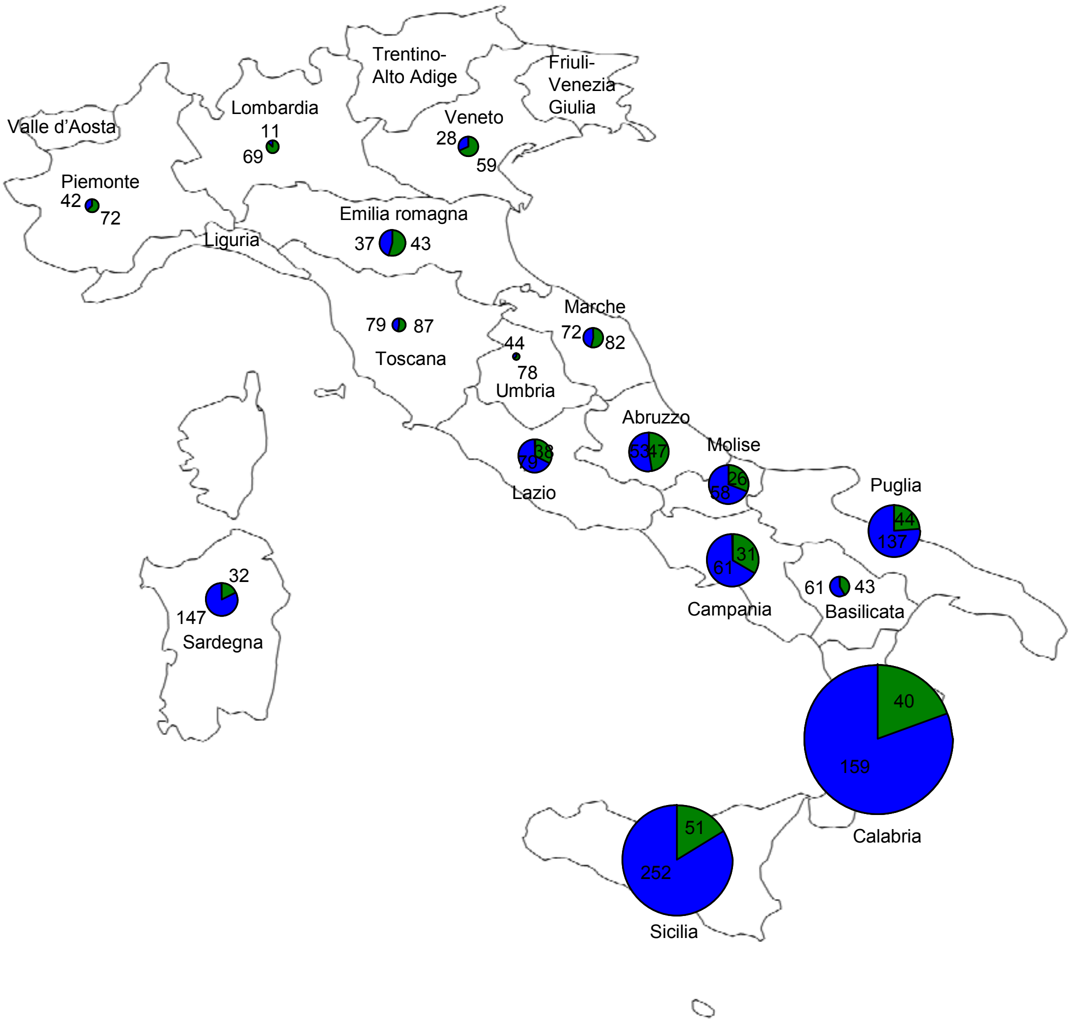

Fig. 4.3 Green and blue water footprint of fresh tomato production by region. The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

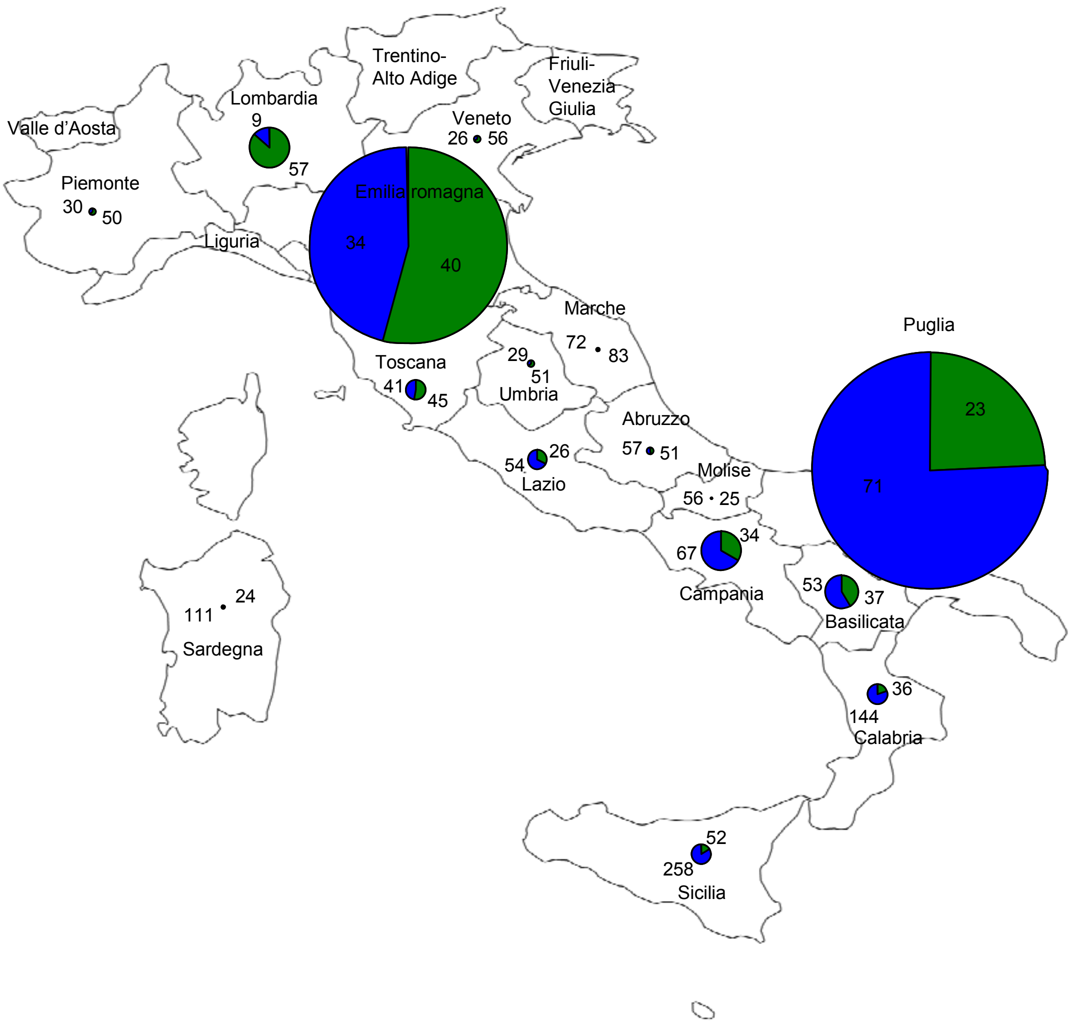

Fig. 4.4 Green and blue water footprint of industrial tomato production by region. The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

The grey water footprint of tomatoes was estimated at country level. We only considered water pollution as a result of the use of nitrogen fertiliser. The grey water footprint of tomatoes shown in Table 4.3 refers to the volume of water required to dilute the nitrogen flow that enters the water system. Contrary to what one might expect, the grey water footprint, in terms of m^3/ton, is noticeably lower for tomatoes (19-31 m^3/ton) than for wheat (166-301 m^3/ton, see Tables 3.1 and 4.1). For wheat, fertiliser application rates are on average 25% lower than for tomatoes, but wheat yields per hectare are on average fifteen times less than tomato yields. In the case of tomatoes, Chapagain and Orr (2009) obtained even smaller grey water footprint figures when looking at tomato production in Spain: 8 m^3/ton for open production systems and 4 m^3/ton for covered systems. It is widely known, however, that tomato production is a very intensive form of agriculture in terms of water use and chemical inputs (Rinaldi et al., 2006). This becomes clear when one considers the nitrogen load per hectare: the average fertiliser application rate in terms of kg/ha is higher for tomatoes than for wheat (110 versus 82 kg N/ha, respectively). One can thus see that the grey water footprint of tomatoes compared to wheat is low when expressed per ton but high when expressed per hectare. The same can be observed for the blue water footprint: relatively low for tomatoes when expressed per ton, but relatively high when expressed per hectare.

Table 4.4 shows the total water footprint of both fresh and industrial tomatoes, adding the green, blue and grey components. Whereas the total water footprint of fresh tomatoes is 199 m^3/ton, it is 114 m^3/ton for industrial tomatoes. The table also shows the water footprint of tomato puree, made from industrial tomatoes. In order to produce tomato puree, ripe tomatoes are cooked until soft and broken down into a mushy pulp. Afterwards, the pulp is passed through a sieve to extract the skins and some seeds. Finally, the tomato puree (passata di pomodoro) is poured into jars and boiled (BBC, 2008a). Since 1 kg of tomatoes on average gives 0.3 kg of tomato puree, the total water footprint of tomato puree is (114/0.3=) 380 m^3/ton.

Table 4.3 Nitrogen application and the associated grey water footprint for the production of tomatoes in Italy.

	Average N fertiliser application rate	Area*	Total N fertiliser applied**	Nitrogen leached to the water bodies	EPA (2005) standard	Volume of dilution water required	Production*	Grey water footprint
	kg/ha	ha	ton/yr	ton/yr	mg/l	10^6 m^3/year	ton/yr	m^3/ton
Fresh tomato	110	23637	2600	260	10	26	828340	31
Industrial tomato	110	95721	10529	1053	10	105	5675751	19

* ISTAT for the year 1999-2007 (ISTAT, 2008)

** FAO (2007) for the year 1999/2000

Table 4.4 The water footprint of fresh and industrial tomatoes and tomato puree made in Italy.

	Water footprint (m^3/ton)			
	Green	Blue	Grey	Total
Fresh tomatoes	44	124	31	199
Industrial tomatoes	35	60	19	114
Puree from industrial tomatoes	117	200	63	380

According to the Mediterranean International Association of the Processing Tomato (AMITOM, 2006), tomato processing enterprises are not always located in the tomato-growing regions. In the Puglia region, in southern Italy, only a few factories have been set up, so tomatoes have to be transported by lorry to processing plants in Campania, 200 to 300 km away. The main production zone in Puglia is around Foggia, but processing tomatoes are also grown further south around Bari and Brindisi (ibid.). The Foggia area is a large plain with soils alternating between a predominance of clay and a predominance of sand. In the north of Foggia, tomatoes are mainly produced for paste, whereas in the south they are grown primarily for canned peeled tomatoes. Water is plentiful but rather expensive to use, which is why drip irrigation is particularly developed in that zone. Sprinklers are the most common alternative to drip systems. The main varieties for tomato paste are now almost exclusively hybrids: Perfect Peel, Snob, Isola, Alange, Amur. In the Campania region, the traditional variety has been awarded the protected origin label: "pomodoro San Marzano dell'agro Sarnese Nocerino" (AMITOM, 2006).

Concerning industrial tomato production in the north of Italy, processing tomatoes are mainly grown around Parma and Piacenza, but also in small areas around Ferrara and north of the Po. Soils near Parma and Piacenza are predominantly clay, with sandy-clay in Ferrara and silt north of the Po. The climate is ideal for tomato cultivation with notably a big difference between day and night-time temperatures, producing a good colour in the fruit. There is a risk of late drought and hail storms. The production of processing tomatoes in this region is completely mechanized and controlled by experts. The use of hybrids is almost complete with Perfectpeel, Guadalete, Pavia, Falcorosso, Isola, Trayan, H9478, etc. UC82 is the only open pollinated variety still used, but with less and less quantities. Plug-seeding transplants are becoming generalized (90%), but direct seeding is still used (10%), using precision seeders.

Irrigation is still partly applied by sprinklers, with coiled hose water guns, but drip irrigation is becoming widespread. The harvest is totally mechanized with self-propelled Italian harvesters. Farm yields are 65 ton/ha on average. In northern Italy, the farm price in 2006 has dropped to 39 euro/ton. Since 2001, the production in northern Italy exceeds the southern one and in 2005, the production in northern Italy amounted to more than 3 million tonnes of raw tomatoes. 40% of raw tomatoes are processed by co-operative factories, which are members of ConfCooperative and 60% by private companies which are members of AIIPA.

Before the restructuring of the Italian tomato processing industry which led to the current situation, nearly 70% of the production of tomatoes for processing was localised in the regions of the south of Italy (Puglia, Campania, etc.), the north only representing 30% of the volumes processed in the country. Over the last 20 years, the distribution of the growing areas has been profoundly modified and now the north has overtaken the south. Several reasons explain this reversal: in first instance, because of the lack of crop rotation, as it has been the case in Campania over many years. A second reason is the gradual shift of the production of industrial tomato paste from the south to the north. The companies in the south of the country have carried on or specialised in the production of tomato products in small packaging, directly intended for retail sales and more profitable.

Moreover, the industry in the north of the country seems to have achieved the necessary concentration which has led to the rise of ten or so major companies relatively specialised on some products (passata, diced tomatoes, sauces, etc.), on some types of services (co-packing, etc) or “tailored” production, depending less on the market variations (niche products, contracted production with given volumes and strict specifications, etc.).

The total number of companies involved in tomato processing is around 200. The volumes of tomatoes processed in Italy have remained stable since 1999 at around 5 million ton/yr. The processing threshold allocated by EU remains 4.35 million tonnes of fresh tomatoes and Italy is starting to get penalised by lower subsidies.

4.3 The water footprint of mozzarella fior di latte

The traditional mozzarella is made from buffalo milk, but mozzarella fior di latte, made from fresh cow's milk, is the most common mozzarella in Italy. The production of mozzarella involves curdling (coagulating) milk with rennet or an edible acidic substance such as lemon juice or vinegar and then draining off the liquid portion (called whey) to obtain curd (Fig. 4.5). The curd is mixed with heated whey, followed by stretching and kneading to produce a delicate consistency – this process is generally known as pasta filata. The cheese maker kneads it with his hands, like a baker making bread, until he obtains a smooth, shiny paste, a strand of which he pulls out and lops off, forming the individual mozzarella. It is then typically formed into ball shapes or in plait.

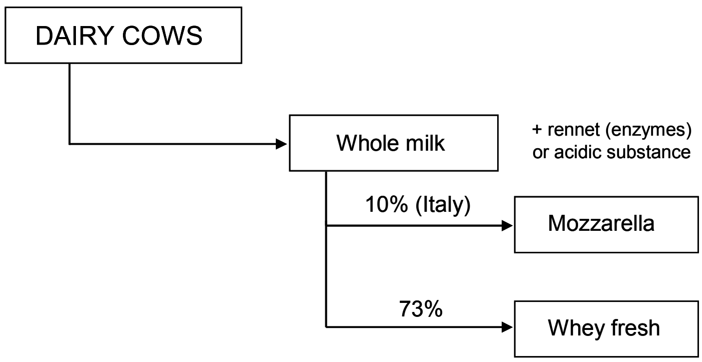

Fig. 4.5 Mozzarella production diagram including product fractions. Source: based on average data from Chapagain and Hoekstra (2004) and Italian data from FAO (2003c).

The average water footprint of the Italian milk is estimated to be 1308 litre/kg, based on a total milk production during the seven-years life time of the cow of 33.5 ton and a total water footprint of the cow of 44000 m^3. The latter figure refers to the water footprint of all feed consumed during the lifetime of the cow (contributing more than 99% to the total) plus the water consumed for drinking by the cow and for cleaning cow facilities (contributing less than 1% to the total).

About 10% of the milk weight becomes mozzarella. Apart from mozzarella, the process provides in whey (Fig. 4.5). The mozzarella forms 54% of the total value of the two separate products. Given a water footprint of milk of 1308 litre/kg and an estimated processing water requirement of 10 litres/kg, we can calculate that the water footprint of mozzarella is (1318×0.54/0.1=) 7117 litre/kg.

4.4 The water footprint of pizza margherita

The basic ingredients for cooking a pizza margherita are bread wheat flour, tomato puree (passata di pomodoro) and mozzarella fior di latte. There are different recipes for cooking the pizza margherita. We have used a traditional recipe for two people following BBC (2008b). There are other potential additional ingredients such as basilica or olive oil which have not been included in the present study. Based on the average figures for its ingredients, we estimate that the water footprint of a pizza margherita is 1216 litres (Table 4.5). If fresh tomatoes would be used instead of industrial tomatoes, the total would be slightly higher, viz. 1244 litres. The largest contribution to the total comes from the mozzarella.

Table 4.5 The water footprint of a pizza margherita.

Ingredients	Weight (kg)	Water footprint per kilogram (l/kg)				Water footprint (litre) of 1 pizza of 725 gr.
		Green	Blue	Grey	Total	Total
Bread wheat flour	0.300	605	154	202	961	288
Tomato puree*	0.100	117	200	63	380	38
Mozzarella	0.125	n.a.	n.a.	n.a.	7117	890
Water	0.2	0	1	0	1	0.2
Total	0.725					1216

* from industrial tomatoes.

5. Water footprint impact assessment

Understanding the environmental impacts of the water footprints of pasta and pizza margherita is particularly important in Italy since the production and consumption of wheat, tomato and mozzarella, their main ingredients, are widespread in this country. Wheat and tomato are two of the main Italian crops, both in terms of production and consumption – with 7.4 and 6.8 Mton/yr produced and 150 and 62 kg/capita/yr consumed, respectively (FAO, 2008) – whereas mozzarella cheese plays an essential role: 77% Italian families eat mozzarella, and 58% at least once a week (Pagliarini et al., 1997).

The environmental impacts of the water footprint are analysed differentiating between the effects of the blue, green and grey water footprint. The impact of the water footprint spatially varies along with the vulnerability of the local water systems where the footprint is located, the actual competition over the water in these local systems and the negative externalities associated with the use of the water (Hoekstra, 2008).

The water footprint of bread wheat, durum wheat and tomato in the different regions is compared with the water scarcity map. As an indicator of water scarcity we used the withdrawal-to-availability ratio as given by Alcamo et al. (2003a, 2003b). The water scarcity map of Italy based on data from Alcamo (Fig. 5.1) shows the same pattern as the water scarcity map by Smakhtin et al. (2004a; 2004b) , which takes into account the environmental water requirements. In this way the high-risk areas or hotspots were identified.

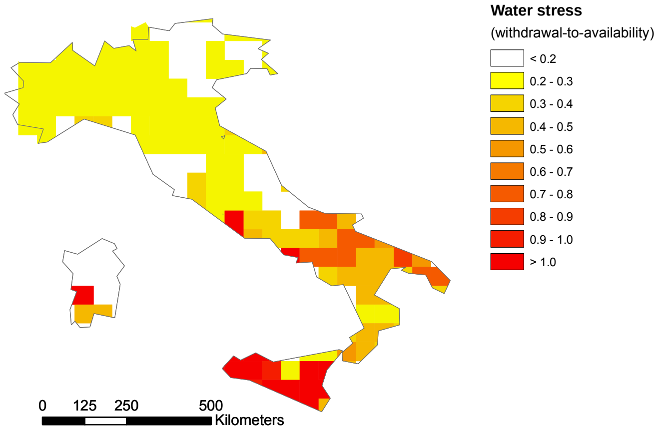

Fig. 5.1 Water scarcity map of Italy. Source: Alcamo et al. (2003a, 2003b).

In the case of pasta production, most of the water is used in the stage of durum wheat cultivation. The water used in the pasta processing is very small if compared with the quantity used in the durum wheat production (0.5 m^3/ton and 1557 m^3/ton, respectively). The durum wheat water footprint thus adds up to almost 100% of the total water used. The cultivation of durum wheat, is the sub-process that accounts for most of the water footprint during the production of pasta. These results can be useful for practitioners in the agri-food industry who wish to improve the environmental performance of their final product over its full supply chain. Since the late 1990s, the Italian producers of pasta have been striving to improve the environmental performance of their own operations and, nowadays, this effort is being extended to the whole supply chain (Bevilacqua et al. 2007).

As shown in Fig. 5.2, Puglia and Sicily are the regions with the highest durum wheat water footprints along with the highest water scarcity levels. Basins with water stress values above 0.4 may be classified as severely water stressed (Cosgrove and Rijsberman, 2000). According to Smakhtin et al. (2004a), in these heavily exploited basins the current water use is tapping into the environmental water requirements. Along these lines, both Puglia and Sicily can be considered as high-risk regions or hotspots, where the high water use may be in conflict with the environmental water requirements and consequently, there is a higher risk of environmental water scarcity. The minimum flow needed for water ecosystems cannot be guaranteed in these regions.

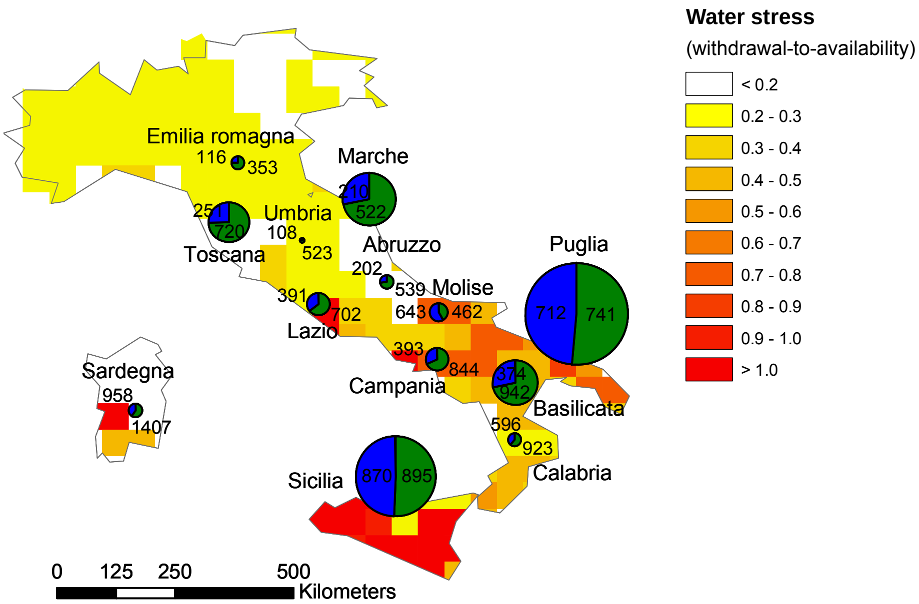

Fig. 5.2 Green and blue water footprint for Italian durum wheat production by region plotted on a water scarcity map of Italy (source: Alcamo et al., 2003a, 2003b). The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

As shown in Fig. 5.3, groundwater abstraction is widespread in both Puglia and Sicily (OECD, 2006). Actually, the most serious water problem in Italy is the increase of groundwater use (National Environment Protection Agency, 2004), which represents the prevailing source of irrigation supply in this country. In particular, in Puglia and in the coastal plains of Sicily pervasive aquifer overdraft and water quality problems exist (OECD, 2006). Several aquifers in Sicily are claimed to be overexploited, such as the case of the Catania plain in eastern Sicily, with negative consequences on its hydrodynamic equilibrium and water quality (Ferrara and Pappalardo, 2004). Furthermore, the development of groundwater extraction is carried out by private users, who are largely outside the control of the water administration (OECD, 2006). In Italy, there are an estimated 1.5 million illegal wells. In eight regions (Abruzzo, Molise, Puglia, Campania, Basilicata, Calabria, Sicilia e Sardegna) about 830,000 ha are irrigated legally while the total of irrigated area reaches about 1.6 million ha. In the Puglia region alone, there are an estimated 300,000 illegal wells, which provide for one third of the total irrigated area in that region (WWF, 2006). On the other hand, aqueducts are also common in these regions. The aqueduct serving Puglia, however, is riddled with so many holes that it leaks more water than it delivers according to a study by the Italian investment bank Mediobanca. The 102-years-old Acquedotto Pugliese, Europe's largest with about 16,000 km of conduits loses 50 percent of the water it carries.

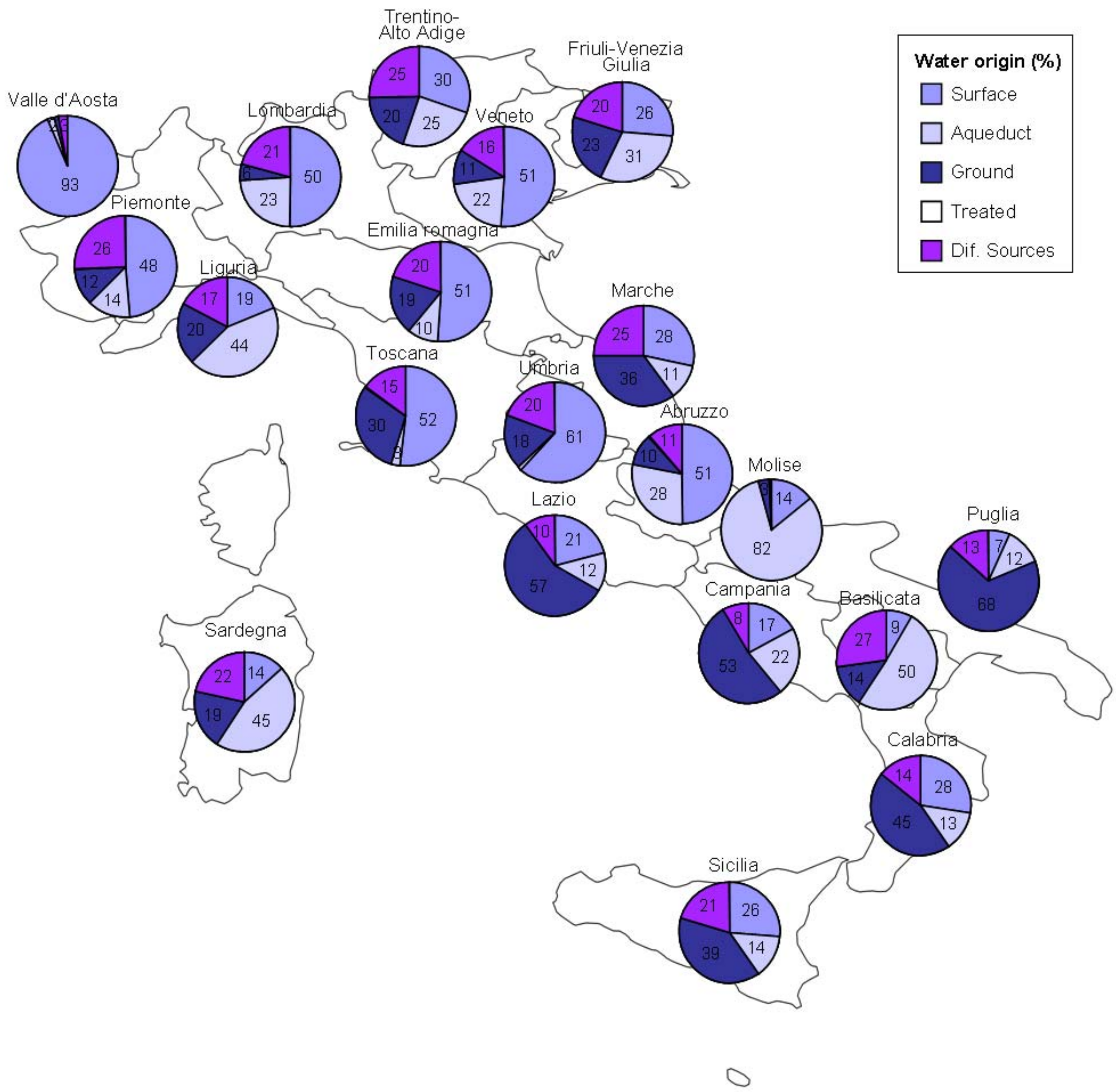

Fig. 5.3 Percentage of the different sources of blue water use by region. Source: ISTAT (2008).

Water scarcity can also emerge from water quality deterioration (e.g. by diffuse pollution from fertilisers). The grey water footprint related to the use of nitrogen fertiliser in durum wheat production in Italy amounts to 301 m^3/ton. According to the OECD (2006), water quality problems exist in both Puglia and in the coastal plains of Sicily.

The water footprint of an Italian pizza margherita is 1216 litres (assuming a pizza of 0.725 kg). Bread wheat flour represents about 24% of the total water use and tomato puree about 3%. For the production of pizza, however, most of the water used relates to mozzarella, amounting to about 73% of the total pizza water footprint (Table 4.5).

Concerning the wheat flour water footprint, most of the water use is for the cultivation of bread wheat. The bread wheat water footprint, however, does not seem to represent a problem since it is produced using mainly green water resources (495 m^3/ton of green water versus 125 m^3/ton of blue water) in the Northern part of Italy where the water scarcity is low (Fig. 5.4) .

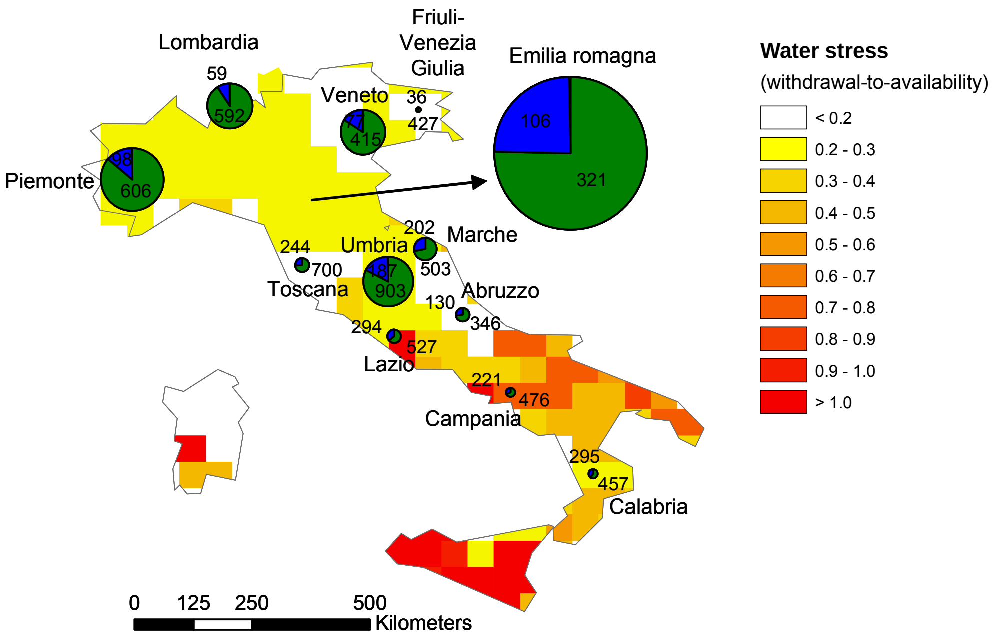

Fig. 5.4 Green and blue water footprint for Italian bread wheat production by region plotted on a water scarcity map of Italy (source: Alcamo et al., 2003a, 2003b). The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

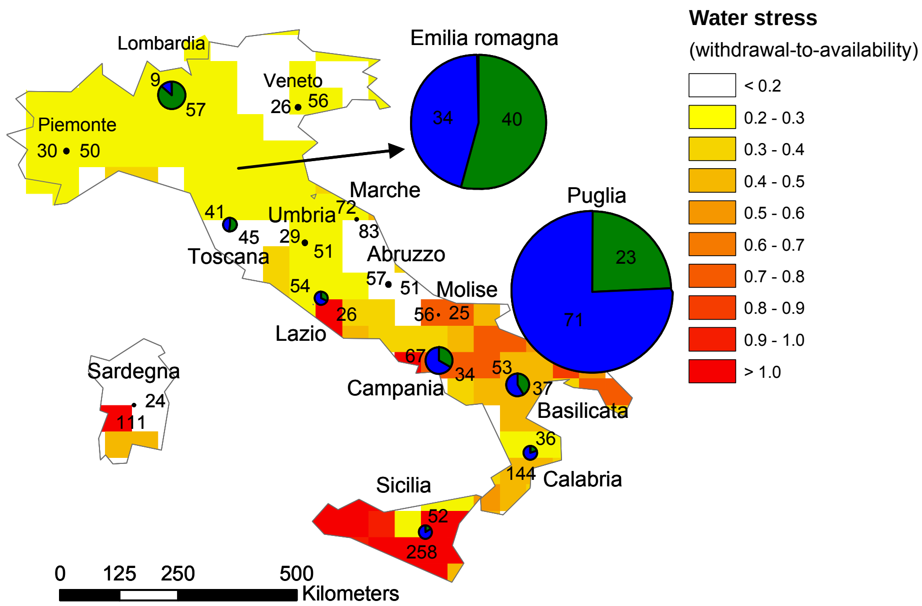

Fig. 5.5 Green and blue water footprint for Italian industrial tomato production by region plotted on a water scarcity map of Italy (source: Alcamo et al., 2003a, 2003b). The size of each pie reflects the regional contribution to the national production. The numbers shown in the pies refer to the water footprint per ton (m^3/ton).

With regard to the tomato puree water footprint, most of the water use is for the cultivation of industrial tomatoes mainly grown in Puglia and Emilia Romagna (Fig. 5.5). The tomato water footprint represents an additional source of pressure to the already scarce water resources in the Puglia region. Highly profitable tomato production takes places mainly in the Po basin in Emilia-Romagna. In this region, the problem is not so much water scarcity but water quality. According to UNEP/DEWA/GRID-Europe (2008), the main environmental problems in the Po basin are related to chemical and organic fertiliser input, and to the use of pesticides. According to our results, the nitrogen grey water footprint related to tomato production, even if it is not the highest among the studied crops, can contribute and perhaps aggravate the already existing problem.

Finally, in the case of the mozzarella, most of the water footprint comes from the indirect water required to produce milk, namely the water required to produce the various ingredients of dairy cow feed. The impact on water resources, thus, will depend on the type and origin of dairy cow feed.

Italy is the principal producer of *Pasta filata* cheeses – or stretched curd cheeses – of which Provolone, Caciocavallo and Mozzarella are the best known members (Fox, 1993). *Pasta filata* cheeses were, traditionally, produced mainly in southern Italy and Sicily, frequently from buffalo milk. At present, however, both mozzarella and milk production are concentrated in the Po valley, often on big dairy farms (Fig. 5.6) (Fox, 1993). We were not able to trace the origin of the feed ingredients applied in this region.

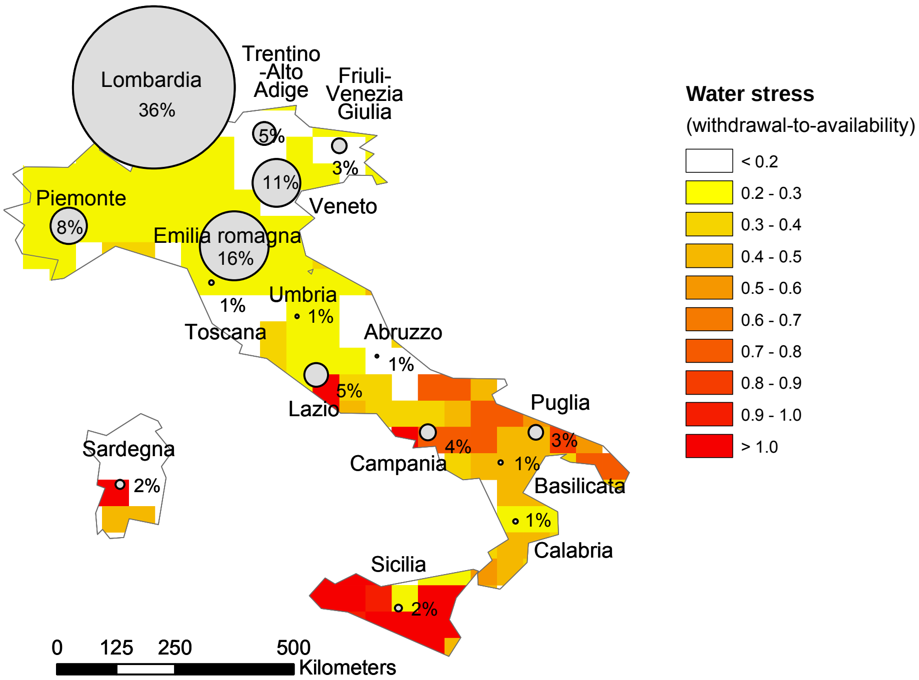

Fig. 5.6 Milk production from cattle (2004). The size of each pie and the percentage in it reflect the regional contribution to the national production. Source: FAO (2009).

Concerning the mozzarella production, the disposal of the dairy liquid waste (whey, acqua di filature or stretching water – water in which the mozzarella has been stretched), represents a significant problem for the dairy industry from the environmental point of view, if we consider the great quantity produced (Faccia, 2008). According to Faccia (2008), processing of 10 kg of milk gives an average of 1-2 kg of cheese and 8-10 kg of liquid waste. A small cheese-factory – that produces about 20 m^3 of liquid waste per day – causes a pollution that can be compared to that of a population of about 10.000 inhabitants. Therefore, despite the important substances the whey contains, according to the current legislation (Ministerial Decree 125/06) it is considered a special waste because of its high pollution load, and the uncontrolled deposit on the soil or the discharge into superficial or underground waters is prohibited (art. 192 paragraphs 1 and 2). Although the wastewater from mozzarella processing contains valuable ingredients for making derived products with a high added value, the costs for this are considerable. In order to avoid serious environmental impacts, it is therefore necessary, when there are no possibilities of disposal at contained costs, to subject whey to treatment before disposal (Faccia, 2008).

In summary, the water footprint impact of pasta is most severe in Puglia and Sicily, where groundwater overexploitation for durum wheat irrigation is common. The impact of the water footprint of pizza is more diverse. It is concentrated in the first step of the supply-chain of tomato puree and mozzarella, i.e. in the cultivation of tomatoes and the feed crops of dairy cows. The bread wheat used for the pizza base does not have large impacts. The water footprint impact of the tomato puree on the pizza is concentrated in Puglia (groundwater overexploitation and pollution related to tomato cultivation) and Emilia-Romagna (water pollution). The water footprint impact of mozzarella lies mostly in the effects of water use for producing the feed ingredients for the dairy cows, but we were unable to locate those impacts due to the absence of good statistics on feed origin. Mozzarella production further poses a potential threat to water quality, mostly in the Po valley, but this problem seems to be properly regulated, although possibly not fully controlled.

Water demand in Italy has been stimulated by a number of factors. These include inadequate pricing systems that do not recover the costs of providing users with water nor stimulate water savings, lack of compliance with water related legislation as well as lack of control by the competent River Basin Authorities (WWF, 2006). Also, there are agricultural subsidies that support production and/or the development of irrigation systems, regardless of water availability. The EU Common Agricultural Policy (CAP) has led to increased water consumption through subsidies which provoked a shift from traditional rain-fed crops to irrigated cultivation. Additionally, EU Rural Development funds have been used to enlarge irrigation areas or to support crops that are high in water demand. This enhancing of irrigated agriculture furthermore stimulates the policy of water transfers and the construction of dams (WWF, 2006). Although the CAP reforms in the last few years have introduced some regulations (CE 1782/2003, CE 796/2004, CE 1698/2005) towards new approaches for EU agricultural funding (decoupling, compliance), in practice national implementations are weakening these changes. It is still to be seen if and how the regulations will be implemented by the member states over the long run.

6. Conclusion

On average, every Italian uses about 380 litres of water a day for domestic purposes, but actual consumption is 17 times higher if we take into account the water footprint used to make the food Italians eat and the clothes they wear. The total comes to some 6,400 litres of water per capita every day. This is the nearly double the world average and among the highest figures in the world. The water footprint of Italian pizza margherita is about 1216 litres. The water footprint of pasta is about 1924 litres per kg.

Water mismanagement is still a widespread issue in Italy. Illegal water users are common in Puglia and Sicily where the water footprint of durum wheat and tomato is high and water is scarce. Illegal water abstraction is a major issue for Italy, with estimates of about 1.5 million illegal wells (300,000 in the Puglia region alone). Furthermore, Italy's south and islands have scant resources, as well as very high leakage rates in the supply system. The price of water does not reflect its value and subsidies hinder the move towards new technologies. This is a key issue. If a commodity's price fails to reflect its significance or scarcity, there is little incentive to prevent excessive consumption or wasting. Improving irrigation schemes and water collection technology is crucial to limiting the use – and waste – of water. In this sense, raising awareness among consumers on the water footprint of the different types of commodities and sources can have an equally significant impact.

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Appendix I Major durum wheat, bread wheat, fresh tomato and industrial tomato producing regions within Italy over the period 1999-2007 and climate stations for each region.

Commodity	Major wheat and tomato producing regions within Italy* and climate stations for each region**
Durum wheat	• Puglia (23%) (Bari-palese macchie, Brindisi, Foggia, Lecce, Palascia, S Maria di leuca, Taranto, Vieste) • Sicilia (18%) (Catania, Cozzo spadaro, Enna, Messina, Palermo boccadifalco, Siracusa, Trapani) • Marche (12%) (Ancona) • Basilicata (10%) (Latronico, Potenza) • Toscana (9%) (Firenze, Firenze peretola, Pisa, Siena) • Lazio (5%) (Civitavecchia, Ponza, Roma Ciampino, Roma) • Campania (5%) (Capo-palinuro, Napoli) • Molise (4%) (Termoli) • Emilia romagna (3%) (Bologna, Ferrara, Parma, Piacenza, Rimini) • Abruzzo (3%) (L'aquila, Pescara) • Sardegna (3%) (Alghero, Cagliari elmas, Guardiavecchia, Macomer, Tempio pausania) • Calabria (3%) (Calopezzati, Caraffa di catanza, Crotone) • Umbria (1%) (Peruggia)
Bread wheat	• Emilia romagna (34%) (Bologna, Ferrara, Parma, Piacenza, Rimini) • Piemonte (14%) (Govone, Torino) • Umbria (11%) (Peruggia) • Veneto (10%) (Padova, Venezia, Verona) • Lombardia (10%) (Bergamo, Milano, Sondrio) • Marche (5%)(Ancona) • Toscana (3%) (Firenze, Firenze peretola, Pisa, Siena) • Abruzzo (3%) (L'aquila, Pescara) • Lazio (3%) (Civitavecchia, Ponza, Roma Ciampino, Roma) • Campania (2%)(Capo-palinuro, Napoli) • Calabria (2%) (Calopezzati, Caraffa di catanza, Crotone) • Friuli (1%) (Tarvisio, Trieste, Udine)
Fresh tomato	• Calabria (23%) (Calopezzati, Caraffa di catanza, Crotone) • Sicilia (17%) (Catania, Cozzo spadaro, Enna, Messina, Palermo boccadifalco, Siracusa, Trapani) • Puglia (8%) (Bari-palese macchie, Brindisi, Foggia, Lecce, Palascia, S Maria di leuca, Taranto, Vieste) • Campania (8%) (Capo-palinuro, Napoli) • Molise (6%) (Termoli) • Abruzzo (6%) (L'aquila, Pescara) • Lazio (5%) (Civitavecchia, Ponza, Roma Ciampino, Roma) • Sardegna (5%) (Alghero, Cagliari elmas, Guardiavecchia, Macomer, Tempio pausania) • Emilia romagna (4%) (Bologna, Ferrara, Parma, Piacenza, Rimini) • Basilicata (3%) (Latronico, Potenza) • Marche (3%) (Ancona) • Veneto (3%) (Padova, Venezia, Verona) • Toscana (2%) (Firenze, Firenze peretola, Pisa, Siena) • Lombardia (2%) (Bergano, Milano, Sondrio) • Piemonte (2%) (Govone, Torino) • Umbria (1%) (Peruggia)
Industrial tomato	• Puglia (36%) (Bari-palese macchie, Brindisi, Foggia, Lecce, Palascia, S Maria di leuca, Taranto, Vieste) • Emilia romagna (30%) (Bologna, Ferrara, Parma, Piacenza, Rimini) • Lombardia (6%) (Bergano, Milano, Sondrio) • Campania (6%) (Capo-palinuro, Napoli) • Basilicata (5%) (Latronico, Potenza) • Lazio (3%) (Civitavecchia, Ponza, Roma Ciampino, Roma) • Toscana (3%) (Firenze, Firenze peretola, Pisa, Siena) • Sicilia (3%) (Catania, Cozzo spadaro, Enna, Messina, Palermo boccadifalco, Siracusa, Trapani) • Calabria (3%) (Calopezzati, Caraffa di catanza, Crotone) • Veneto (1%) (Padova, Venezia, Verona) • Piemonte (1%) (Govone, Torino) • Abruzzo (1%) (L'aquila, Pescara) • Umbria (1%) (Peruggia) • Sardegna (0.4%) (Alghero, Cagliari elmas, Guardiavecchia, Macomer, Tempio pausania) • Marche (0.4%) (Ancona) • Molise (0.2%) (Termoli)

**Source: ISTAT (2008).*

***Source: CLIMWAT (FAO, 2003b)*

Appendix II Evapotranspiration (mm), crop water use (m^3/ha), yield (ton/ha), production (%) and the green and blue water footprint (m^3/ton) for wheat and tomatoes per region.

	ET_g	ET_b	ET	CWU_g	CWU_b	CWU	Y*	WF_g	WF_b	Prod*
	mm	mm	mm	m^3/ha	m^3/ha	m^3/ha	ton/ha	m^3/ton	m^3/ton	%
DURUM WHEAT										
Puglia	186	179	364	1859	1785	3644	2.5	741	712	23
Sicilia	210	204	415	2104	2045	4149	2.4	895	870	18
Marche	209	84	293	2090	840	2929	4.0	522	210	12
Basilicata	218	86	304	2175	864	3040	2.3	942	374	10
Toscana	221	77	297	2206	769	2975	3.1	720	251	9
Lazio	220	122	342	2196	1223	3419	3.1	702	391	5
Campania	246	115	361	2464	1147	3610	2.9	844	393	5
Molise	127	176	303	1268	1764	3032	2.7	462	643	4
Emilia romagna	194	64	258	1937	639	2576	5.5	353	116	3
Abruzzo	196	73	269	1958	734	2692	3.6	539	202	3
Sardegna	215	147	362	2151	1465	3616	1.5	1407	958	3
Calabria	226	146	371	2255	1456	3711	2.4	923	596	3
Umbria	214	44	259	2144	444	2588	4.1	523	108	1
Weighted average Italy								748	525	

	ET_g	ET_b	ET	CWU_g	CWU_b	CWU	Y*	WF_g	WF_b	Prod*
BREAD WHEAT										
Emilia Romana	194	64	258	1937	639	2576	6.0	321	106	34
Piemonte	198	32	230	1979	319	2298	3.3	606	98	14
Umbria	214	44	259	2144	444	2588	2.4	903	187	11
Veneto	202	38	239	2017	376	2393	4.9	415	77	10
Lombardia	223	22	245	2230	222	2452	3.8	592	59	10
Marche	209	84	293	2090	840	2929	4.2	503	202	5
Toscana	221	77	297	2206	769	2975	3.2	700	244	3
Abruzzo	196	73	269	1958	734	2692	5.7	346	130	3
Lazio	220	122	342	2196	1223	3419	4.2	527	294	3
Campania	246	115	361	2464	1147	3610	5.2	476	221	2
Calabria	226	146	371	2255	1456	3711	4.9	457	295	2
Friuli	242	20	262	2421	202	2623	5.7	427	36	1
Weighted average Italy								495	125	

	ET_g	ET_b	ET	CWU_g	CWU_b	CWU	Y*	WF_g	WF_b	Prod*
	mm	mm	mm	m^3/ha	m^3/ha	m^3/ha	ton/ha	m^3/ton	m^3/ton	%
FRESH TOMATO										
Calabria	126	505	631	1263	5051	6315	32	40	159	23
Sicilia	110	544	654	1096	5442	6538	22	51	252	17
Puglia	149	467	616	1490	4674	6164	34	44	137	8
Campania	188	375	563	1878	3752	5630	62	31	61	8
Molise	158	348	506	1578	3483	5060	60	26	58	6
Abruzzo	233	261	494	2330	2610	4940	49	47	53	6
Lazio	183	381	563	1826	3807	5634	48	38	79	5
Sardegna	112	517	629	1124	5168	6291	35	32	147	5
Emilia romagna	271	229	499	2706	2285	4991	63	43	37	4
Basilicata	223	318	541	2227	3182	5410	52	43	61	3
Marche	274	238	512	2740	2377	5117	33	82	72	3
Veneto	301	143	444	3015	1428	4442	51	59	28	3
Toscana	277	252	529	2771	2515	5286	32	87	79	2
Lombardia	375	60	435	3750	595	4345	55	69	11	2
Piemonte	267	158	426	2674	1585	4259	37	72	42	2
Umbria	288	162	450	2877	1620	4497	37	78	44	1
Weighted average Italy								44	124	

INDUSTRIAL TOMATO										
Puglia	149	467	616	1490	4674	6164	65	23	71	36
Emilia romagna	271	229	499	2706	2285	4991	68	40	34	30
Lombardia	375	60	435	3750	595	4345	65	57	9	6
Campania	188	375	563	1878	3752	5630	56	34	67	6
Basilicata	223	318	541	2227	3182	5410	60	37	53	5
Lazio	183	381	563	1826	3807	5634	70	26	54	3
Toscana	277	252	529	2771	2515	5286	61	45	41	3
Sicilia	110	544	654	1096	5442	6538	21	52	258	3
Calabria	126	505	631	1263	5051	6315	35	36	144	3
Veneto	301	143	444	3015	1428	4442	54	56	26	1
Piemonte	267	158	426	2674	1585	4259	53	50	30	1
Abruzzo	233	261	494	2330	2610	4940	46	51	57	1
Umbria	288	162	450	2877	1620	4497	57	51	29	1
Sardegna	112	517	629	1124	5168	6291	46	24	111	0
Marche	274	238	512	2740	2377	5117	33	83	72	0
Molise	158	348	506	1578	3483	5060	63	25	56	0
Weighted average Italy								35	60	

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